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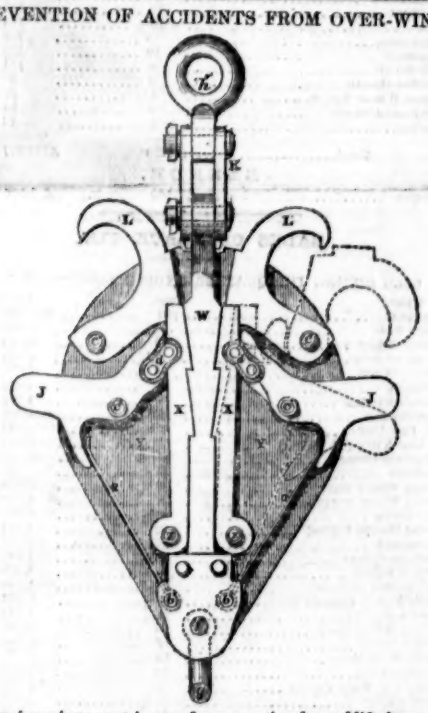
PREVENTION OF ACCIDENTS FROM OVER-WINDING.



A very ingenious contrivance for preventing loss of life from overwinding in the shafts of mines, invented by Mr. Samuel Bailey, of Wednesbury, was referred to by our Staffordshire correspondent, in his letter of last week, and, in accordance with the promise then made, we subjoin a more detailed description, with the necessary explanatory diagram. At most collieries, not only in Staffordshire, but in every district in the kingdom, the safety of the men ascending in the cage is dependent entirely upon the precision with which the engineer handles the engine. It is true that by continued practice he becomes so perfect a master of the machine, that the cage is brought to bank five hundred times without being permitted to rise a foot above the required height; but the fact must not be lost sight of, that a moment's absence of mind on the part of the winder is sufficient to sacrifice the lives of those in the cage, and at the same time to do no inconsiderable damage to the gearing at the mouth of the pit. It is precisely to render this operation less dependent upon the individual attention of the engineer that Mr. Bailey's apparatus is devised; and it certainly appears every way calculated to effect the object in view.

To render the annexed diagram intelligible, it may be stated that between the pit's mouth and the pulley over which the winding-rope passes there is provided a cross bar, in the centre of which is a ring, which surrounds the rope. While the starting and the stopping of the engine is properly attended to, the winding-rope being attached to *h'*, and the cage suspended from *g'*, the lowering and drawing goes on as if no safety apparatus were attached; but when, from negligence of the winder, the cage proceeds onward toward the pulley, the arms *J J* strike with force against the lower side of the ring already referred to, and draw back the bars *X X*, by which the bolt *W* is kept in position, throw the hooks *L L* over the ring, and leave the cage suspended by these hooks; whilst the bolt *W* and the shackle *K* are left free to pass over the pulley.

The arms *J J* are levers, *c' c'* being the fulcra, and *d d'* flat chain-links, by which the bars *X X* are drawn back; *e' e'* are the pivots on which the hooks turn when acted upon by the points of the levers *J J*; *a' a'* are springs passing round strong pins *b' b'*, and which serve to keep the arms *J J* and the bars *X X* in position when not acted upon by the pressure of the ring; and *Z Z* are the pivots on which the bars *X X* turn. A flat plate of iron has been removed in this drawing to render the interior construction visible.

Mr. Bailey does not confine himself to the precise details given, it being obvious that his invention is capable of much modification without departing from the general principle involved. Thus any kind of stop may be used to act upon the levers by which the cage is disconnected from the winding-rope, and as the hooks are in most cases sufficient to prevent the cage from descending, he sometimes provides auxiliary stops, and sometimes dispenses with them.

COLLIERY OPERATIONS—GETTING COAL BY THE LONG WALL SYSTEM.

At the Bristol Mining School, Mr. Lionel Brough, Government Inspector of Coal Mines for the Western district, delivered an interesting lecture, showing the desirability of extending the long wall system of working coal. There is one way better than another for getting every individual seam, and in previous lectures he had pointed out the necessity of studying the bed itself, and all its concomitant strata, before determining the method of excavation; but when the mode has been decided upon all subsequent operations should be in perfect harmony with the principle involved. The two normal processes of getting coal are by pillar and stall and long work, all others being but a modification of one of them, or a combination of the two. It is easy to conceive that at the earliest period of the use of coal it would simply be taken from the bassetting; but in course of time all such mere digging of the outburst would exhaust itself, and then advantage would be taken of the valleys, and levels would be driven from the daylight, and then turn to the right and left. It is clear that in lands of low elevation any such winning would not last long, though in mountainous districts large quantities of coal might be thus gotten. The next expedient resorted to would be the sinking of small shafts to a depth within the limits of manual labour, and the winch or jack roll would be the simple machine used for raising the water and coal. When this primitive method failed to supply the increasing demand animal power would be thought of, and a still deeper portion of the mine won with the gin or horse-whim. But during all these periods the processes of excavation and ventilation would be rude enough, and only such coal as was best adapted to their wants, or most easily gotten, would be taken. By and bye came the water-wheel, which was used for winding as well as pumping: by this power a still greater depth would be attained. At length arrived that grand epoch when the steam-engine was fairly set to work, and then the pits became deeper than at any previous period in the history of coal mining, with, of course, commensurate wider area for exploitation. It is most likely that with this wonderful addition of strength and power some regular order in cutting the coal and in airing the mine came into immediate and permanent operation.

In the North of England the pillar and stall system soon became well developed, and from time to time has undergone such improvements that it is now unsurpassed by any other district in that particular mode of working. Of late years, however, the long wall way has crept in there, and it is probable that the time will arrive when Northumberland and Durham will exhibit as much perfection in the one method as they have previously shown in the other. A partial commencement has also taken place in Monmouthshire and South Wales, and when the workmen get well accustomed to the system it is not unlikely to prevail extensively in that magnificent coal basin, where, indeed, the measures are peculiarly adapted to it. In Gloucestershire, on both sides of the Severn, it has long been practised, and somewhat extensively also in Somerset. In Shropshire, Staffordshire, and Derbyshire it is in high repute, and may be witnessed in great perfection.

It will at once be felt that so great a gift as coal should be sparingly and properly dealt with. In times past, how much coal has been sacrificed in the pillars of ill-worked mines? How much of the small, the result of holing and crushing, has been cast back and left underground for ever? What enormous quantities of good slack have been brought to bank and left on the surface, to be trodden under foot, or to ignite, and poison the wholesome air with its smoke. How large a quantity per annum is dispersed into the atmosphere by the rude and inartificial arrangement of furnaces and fire-places. If, then, there be one way easier and more abundant than another for clearing our mines of coal, surely it becomes a duty to recommend its adoption. He did not state that the long wall system is exactly suitable to every seam of coal, but he believes that there does not exist very many whose peculiarities form a denial to such manner of working. He has seen it in operation in the thinnest and the thickest beds in England, and has had reason to be entirely satisfied with the result. By this method, generally speaking, larger quantities are gotten per acre than by the pillar and stall system. Again, the long sides of work are favourable to straight and unobstructed currents of air, and if the gob be carefully attended to it is a safe method as regards the workmen, and surely human life should be thought of before all else. These are strong arguments, in which he thought he would be borne out by the experience of at least half a dozen of the principal mining counties of the kingdom.

In the long wall system of excavation they make use of any stone or clod that may form partings in the coal, for the purpose of building their pack walls; or if the roof fall behind them they bring it out of the waste for a similar purpose. But there are some veins without partings, and some whose roofs are so strong that they will not always come down. In this case studs of timber are set, which, with any stowed small coal, are nearly always trusted to. He remarked that all the useful contents of the seam should be brought to grass, and he opined that the time will come when stone, strong shale, or other such material, will actually be sent down the pit to gob with, in order that no coal whatever shall be recklessly sacrificed and left underground. He was happy to say that an instance had come under his notice on the other side of the channel where one portion of the coal is now getting by long wall, and the necessary material for gobbing is obtained from a more ancient part of the mine, formerly worked by the pillar and stall. This not only shows a desire for improvement, but it also exhibits the fact that though the colliery was originally laid out for pillar and stall it is still not too late to apply the more productive method. He must also, however, refer to an attempt of a less successful character,—a gentleman entertained the laudable design to adopt the long wall mode, and drove onwards for some time without building up a pack wall. Unfortunately this remissness was attended with a heavy fall of top, and a fatal result, which so alarmed the workmen that they made considerable opposition to the system,—which he might remark had been thrown back in that neighbourhood for, perhaps, many years yet to come. This only shows that alteration or reform without sufficient practical knowledge is always likely to defeat its own end and intention. In a third instance they have turned a modified sort of long work into the true plan, and the result is so gratifying that the workmen themselves cannot do otherwise than admire it; the manager in this instance thoroughly understood what he was about.

Mr. Brough would repeat that your coal and your general stratification must always be well studied before you fix upon the method of working. With reference to the plan adopted in some parts of North Staffordshire, in Derbyshire, and in some other districts for flat mines, or for seams lying at an angle of (say) not more than a foot in a yard, he explained that a very thick pillar is left to protect the main heading and adit level. He much approves leaving a thick rib for this purpose, as it keeps all safe at the lower part of the work, and nothing is lost by it, as the pillar can always be robbed back when the mining operations have reached the far end: remember that no coal whatever should be left underground. The coal is then wrought upwards, and of course the face of the workings advances towards the rise. The coals are brought down to the main roads through a sort of jig-brow, or inclined plane, by means of pulley wheels fixed in strong movable frames, and fitted with brakes in the usual manner. All the coal is removed, and the inclines are kept open and good by sound pack walls or gobbing; also the work is carried on by leading and following faces; and if the roof be hard or heavy they generally carry the stalls, as one may call them, about 10 yards one in advance of the other, so as to break the weight. As to the range, that will depend on circumstances,—it may go up as far as 200 yards, and even more, or it may be prudent not to exceed 50 or 80 yards. If the mine be perfectly flat, the roof good, and horse-roads well kept, even these limits may be extended, but all will depend on the ability to keep the roadways secure. As regards the face of the work, timber is used sometimes—even chocks. His own idea is that cast-iron stobs or supports may be used with great effect; they need never be lost, but made to serve over and over again to any length of time. By the break which 10 yard advances afford the roof, even if a bad one, comes down to its bearing; and though it may be a fiery mine there is not so much danger of the goaf in this manner. If it be a strong top, that only falls in places, the goaves become dangerous, but the remedy will be the exclusive use of locked safety-lamps. There is a division into districts, on one range by means of a leading split of air, and there are also sub-splits if the term may be allowed, in such manner that the air enters two following inclines at once, and then it sweeps along the face of work and the edge of the goaf at the same time; he had seen it thus at work in very fiery mines, but, of course, no naked flame was permitted. The incline machines, or pulleys as they call them, are a little in advance of the face of work, and from time to time they must be moved up, the little head for which is always excavated in readiness. In many mines he had seen a mere snatch block used for letting the coals down to the main road, but that must be regarded as a very slovenly way of doing things.

Reference was next made to a different arrangement adapted to the working of seams varying from 18 in. to 2 ft. in a yard incline, which is heavy indeed to work coal. In this case the main roads are driven to the rise in the solid coal, and one of them becomes a grand inclined plane, with machine and brake, as usual, for letting down the coal. Out of these grand main inlets the levels are driven in pairs to the end of the district, in some instances, and so the coal is worked homewards, or by the back stroke. In other instances the coal is worked outwards, and in this latter case they are obliged to keep the levels good by pack walls—it is needless to remark that by the back stroke less gobbing is necessary. It is but too true that there is a great deal of expensive narrow work, but it must be remembered that the measures are assumed to be lying at a terrible angle. However, they get all the coal out this way, and that is the great object, after all. In this way of working, of course, shorter ranges are prescribed. The lateral distance between the inclines must needs be considerable, otherwise the expense would be greatly increased, as they are generally double headings, in order to carry the air in with them, for in these pitching measures good ventilation is the first thing to be considered.

In some parts of Yorkshire they employ what is there called long work, but it is by no means the pure principle, being but a mixture of long wall and wide-stall work. It is very like the Lund Hill arrangement before the terrible explosion took place, and than which, for the seam of coal there wrought, nothing could be much worse. The pillar left by the fifty-yard stalls is sure to get much crushed, and both coal and ventilation becomes injured; he referred to this system as a warning, not as an example. It is far better to take all the coal out right away, or to revert at once to the system of true pillar and stall. A strong gob will enable you to clear out all the contents of the seam, whatever that may be; but, unfortunately, it is not in every district that they know how to make a thorough good pack wall, and so, when attempted by inexperienced persons, the long wall system gets into disrepute; men accustomed to pillar and stall will nearly always oppose themselves to long work.

Referring to the plan adopted by one of the principal firms in South Staffordshire, with which colliery he was well acquainted, and the workings of which he considered to be a true type of the long wall system of getting coal, Mr. Brough remarked that he must explain a widely different state of things to any observed in most of the very large collieries in the kingdom; in these latter, as soon as the pits have bottomed the coal, and all the necessary arrangements for inset and other suitable room are effected, they immediately commence getting coal, working away outwards; and if by pillar and stall, leaving sufficient support for protection, and these pillars they always get as much of as they can by the second working—that is to say, in coming homewards again; though he might observe that, by dividing the work into districts, one might see operations going on simultaneously both in the whole coal and in the broken. If, on the other hand, they adopt long work, it is for the most part outwards also, the roof being kept good, and the various avenues preserved, by strong pack walls, thus constituting most of their openings of the class termed "gob roads." In South Staffordshire and East Worcestershire, on the contrary, the general custom is to drive out the gate roads and the air heads without attempting to get any coal whatever, more than that which results from these necessary excavations. Sinking is done at a less cost there than in any other part of England, consequently they can afford a pair of shafts for a very limited area of coal; and this is an advantage which they pre-eminently possess. The result of this plan (a most admirable one where it can be performed) is, that they arrive at their extreme boundary in solid coal, and then they commence to work homewards. Thus they always possess fast roads—a means of safety beyond all measure desirable. This is the general plan, but they do not always carry it out; hence it was that in his official reports for that district he frequently complained of "gob roads." That such remonstrance was just and proper there can be no doubt, because with their small areas it is most easy to reach the boundary by fast roads; and in that way, moreover, they bring the coal back cleaner, and carry the air much better, on account of its not leaking through the gob. He could not conscientiously make a similar complaint in his new district, on account of the collieries being for the most part of vast area, and lying very deep; therefore, when a proprietor has expended a very large capital in winning his coal, he can scarcely keep his hands off it, and immediately commences to turn some stalls or cut out a side of work, as the case may be. But for all that he remains steadfast in his opinion, that the safest and best way is to drive the work out to the far end, and then come sweeping homewards, leaving all danger and effluvium far behind.

The system he now wished to explain was the one pursued in Staffordshire, far more extensively in the thin mines than in the ten-yard seam; though he wished it had been entirely adopted in that wonderful mass of coal, as hundreds of lives would have been saved during the last 20 years had such been the case. He was happy, however, to say that the system is creeping in even in that immense aggregation of coal. The grand example set in the collieries belonging to Mr. Foster, and in those of Mr. B. Gibbons, sen., will ultimately be extensively followed. The system was applicable to coal of any thickness, whether 18 in. or 12 yards. After the

pits had reached the coal they drove out level course right and left, and then started off to the rise with very long gate roads, each about 7 ft. square, until they reached the extreme boundary of the colliery—each road, whatever might be its direction, being accompanied by a parallel air head. They cannot get out far from the bottom without these headings, as the coal is sometimes very fiery indeed. About every ten yards they thirl from gate road to head, and then put a strong stopping in the previous one; in this manner they can drive out in solid coal to any distance whatever. About a fourth of the coal was gotten when a plan of workings (exhibited) was handed over to him, but long ere the time at which he was speaking every ounce of coal had been cleared out of the mine. The partings and the roof which falls behind them become the means of perfect safety, every bit being built up into a noble wall of defence behind their backs throughout the entire length of each working face; it is brought on, just leaving room enough for the holers and for the trams and horses, wastes of 3 or 4 yards wide being left in the gob to go in and get building stuff out of. It may easily be conceived what a beautiful sweep of air can be realised in this way, and it is obvious that all that is noxious is left behind them for ever. The rails are laid as close to the face of work as may be convenient, but it is clear that it must be a movable road, retreating homewards as the side of work tends that way. This may be regarded as a disadvantage, but as the road remains where it is until an entire slice comes off the whole long face, it is not so inconvenient as it would at first appear: he thought that they would agree with him that as regards the getting at the coal in order to hole and cut it, and transporting it to the bottom of the pit, nothing can surpass this simple plan, indeed, the haulage gets daily easier and cheaper. As to the process of ventilation, it is evidently the most complete that can be devised, inasmuch as all complication is avoided. He might freely tell them that in the collieries worked on this system (and the two great owners already named possess many of them) not a man was hurt during all the time he was Inspector of the district; whilst, on the contrary, in those mines worked by pillar and stall, or, as it is called there, "square work," accidents were of almost daily occurrence. This is the highest praise he could offer to the long wall system!

In conclusion, he might remark that some coal works easiest on the back of the slips, some under the face of them, and again with some it is expedient to take the coal at its edges. But be this as it may, all or any of these peculiar structural conditions of the seam are just as accessible by long work as by pillar and stall; indeed, he might say a good deal more so. He had explained several methods, all different, yet in some measure so alike that it will be hard indeed if one cannot adopt the best of them when called upon to work coal for one's self or for others. By trying, all things can be done, and he hoped the day would come when no one would leave underground a pound of coal per acre. All that is unskilfully left behind is lost to mankind forever, and this is evidently unjust to the generations that have to succeed us.

THE MINES AND MINING DISTRICTS OF WEST CORNWALL.—No. IV.

Continuing the preliminary description of the principal Cornish Mining Machinery, which I shall conclude in this paper, we next come to—

The Double-Acting Cornish Engine, which is used where a rotary motion is required, and calls for no special remarks. It is, like the pumping-engine, condensing, high-pressure, and expansive, the steam being admitted alternately on each side of the piston, the opposite side being simultaneously placed in connection with the condenser, and the high-pressure steam being cut off after a certain length of the stroke, which is completed by the expansion. The mass required to store up and distribute regularly the momentum given by the high-pressure steam at the beginning of the stroke is supplied by the fly-wheel. This kind of engine is principally used for drawing stuff, or stamping and crushing the ores; but it is likewise, in small mines, at times used for pumping, although, being unsuited to the pumps described, its use in this manner always entails a considerable loss in fuel, compared with the single-acting pumping-engine. How far this class of engine might be economically employed in connection with double-acting pumps has never been seriously considered in Cornwall; but in some countries, where a more portable and cheaper machine, capable of doing the same work, would be more advisable, even if it entailed some increased consumption of fuel, it would be well worthy of consideration how far a system of good double-acting forcing-pumps, in connection with a double-acting engine, might not be usefully adopted. Such systems are in use very successfully in some parts of the Continent.

The Cornish Boiler, which differs essentially from the boiler ordinarily in use in other parts of England, is, like the application of high-pressure steam to the pumping-engine, due to the genius of Trevithick, being conceived by him about 1804, although not used in Cornwall for some years afterwards,—the first erected in the county being at Dolcoath Mine, in 1816. It consists of a horizontal cylinder (containing the water), in which is placed another internal cylinder tube, or flue, of much less diameter (having the furnace at one end), and quite surrounded by the water in the larger cylinder. The heated current traverses this internal tube through its entire length, at the end of which it divides, returning by lateral flues on each side of the outer cylinder, in front of which it again unites, passing down by another flue beneath its bottom, which leads it to the chimney. The fire-grate, placed at the end of the internal flue, slopes a little inwards, the far end being supported by a bridge of brickwork built in the tube; the fire is thus surrounded on all sides by water, so that not only is the heat utilised in every direction, but the ashes are even turned to account. But the peculiarity of the Cornish boiler is not confined to its form alone; it is also characterised by the following features:—

1. The proportion of the area of the heating surface of the boiler to the quantity of water evaporated, or of fuel consumed, in a given time, is from *eight* to *ten times* as great as in a common boiler.

2. The proportion of the area of the heating surface to that of the fire-grate is more than *twice* as great.

3. The rate of combustion is *four times* as slow in the Cornish boiler as in the common one.

The forms and proportions of the Cornish boiler have been the subject of much discussion among engineers unconnected with the county. By some they have been most emphatically condemned, and by others equally lauded. The practical economical results arising from the use of this form of boiler is the best reply to its traducers; but, at the same time, it may be admitted that its success is to some extent due to the nature of the engine in connection with which it is employed, and that for ordinary purposes it might be unsuitable. The two principal objections made are—1. That the very large proportion of the heating surface to the quantity of water evaporated unduly and unnecessarily increases the size, weight, and consequent cost of the boiler.—2. That the small amount of steam room, which is necessarily very contracted from the nature of the form of the two cylinders, gives rise to "priming," or the carrying up of an undue quantity of vesicular water with the steam. To the first it may be replied that the increased first cost is trifling compared with the continued saving of fuel. The second is, no doubt, a formidable objection, and much of the bad duty of many Cornish engines is to be attributed to the "priming," or quantity of water carried over with the steam; but even this is not so bad in the Cornish boiler as it would be with only a similar steam space in any other form of boiler, for the steam being principally generated over the convexity of the internal tube it has only to travel a few inches, whence the ebullition, and consequent chance of "priming," is much less than in an ordinary boiler, where, being generated near the bottom, it has to ascend through many feet of water. Besides, this want of steam space, and consequent tendency to "priming," has been to a great extent remedied in some modern engines, by placing a large reservoir for steam transversely across and above the boilers, to which the steam-pipes are connected, as described by Mr. Sims in the Journal of Nov. 5, as applied to the boilers of Great Wheal Busy engine.

The following extract from Mr. Pole's *Treatise on the Cornish Pumping-Engine* sets forth the advantages of combustion arising from the forms of this boiler in a very clear and forcible manner:—

> The descending arrangement of the flues, which possess several important advantages, is peculiar to the modern Cornish boiler; neither Watt, nor Smeaton, nor any others who had previously placed the fire inside the boiler having so disposed them. In their boilers the fire is placed immediately under the lowest part of the boiler, and the heated current, after having swept along the bottom surface, is made to ascend, and then to pass through flues situate at a higher level, from which it is afterwards drawn into the chimney. The consequence of this process is that, as the coldest water will naturally always be found at the bottom of the boiler, the heated current will always first be applied to the coldest water; and when it is afterwards returned along the flues, instead of finding a cooler surface than that first traversed to act upon (which would be more favourable to the further extraction of its heat), it meets with one hotter than before; wherefore, since the rate of cooling always depends upon the difference of temperature between the bodies in contact, it must follow that in this case the circumstances are not such as should lead to the most perfect and economical use of the fuel.
>
> But with the Cornish boiler the arrangement is quite on a contrary principle. The heated current first impinges on the top of the tube, over which the highest, and therefore the hottest, portion of the water is lying; it then passes along the side flues, when it finds the surfaces cooler than before; and, last of all, it traverses under the bottom of the boiler, where the coldest water will always be. By this means the fire current, as it gradually cools, is likewise gradually brought to act upon cooler water, and thereby the best opportunity is afforded for the extraction of the free caloric it contains.
>
> The plan of making the current impinge upon the coldest surface immediately on its leaving the fire, as in the Boulton and Watt's boiler, is disadvantageous, inasmuch as it tends to check the perfect combustion of the gases evolved from the fire. It is known that a considerable quantity of combustible vapours disengaged from the burning materials is not consumed till it has passed into the throat of the furnace, and has had time to mingle above the fire with the air necessary for its combustion. But if, in the meantime, this gas is much cooled it will not ignite, and passes unconsumed into the chimney; hence smoke is formed, and waste of fuel is the result. It is, therefore, always desirable to cool the gases as little as possible immediately on their departure from the fire; and the difference between the Boulton and Watt and the Cornish systems in this respect is, that in the former the gaseous current impinges at the bridge upon that part of the boiler whose temperature must of necessity be the lowest; while in the latter the the water directly above the fire is the hottest that can be found in the boiler, being, in fact, that of high-pressure steam.

According to the Report of the Admiralty Coal Investigation (*Memoirs of the Geological Survey*, vol. ii., part 2, p. 555), 1 lb. of good Welsh coals can theoretically evaporate a weight of water varying from 13 lbs. to 15 lbs. from the boiling point. In practice, Mr. J. A. Phillips found that the boilers at Par Consols Mine evaporated 10·2 lbs. of water from 92°, equal to 11·4 lbs. from 112°, with 1 lb. of a superior coal, whose theoretical evaporative power nearly equalled 15 lbs. If we take a mean, we may assume that 1 lb. of good Welsh coal will, in a good boiler, convert 9½ lbs. of water into steam from the usual temperature of the feed supplied to the boiler from the hot well.

While steam remains in contact with its generating water, it is a well-known principle that it is impossible to augment its temperature without, at the same time, augmenting its pressure and density in a proportion which has been ascertained by experiment, but for which no general law, applicable to all temperatures, has been found. It is also an established principle that the same quantity of heat will evaporate the same weight of water, whatever the temperature and pressure of the steam; but the quantity, or "volume," of the steam will be proportionately less as the temperature and pressure increase. This varying volume of steam, generated by a given volume of water at different temperatures and pressures, is called its "specific volume." Thus, a cubic inch of water evaporated at a pressure of 15 lbs. to the square inch produces 1665 cubic inches of steam; while at a pressure of 60 lbs., with the same consumption of fuel, it only produces 466 cubic inches of steam, but then this steam is four times more elastic, and has consequently more power. In these cases we find that at 15 lbs. to the inch the specific volume of steam is 1665 cub. in.; and at 60 lbs. 466 cub. in. This relation is very important in considering the power of steam-engines; and the following table, from Count de Pambour, will give a notion of these at some pressures:—

Pressure.	Temperature.	Specific vol.	Pressure.	Temperature.	Specific vol.
15 lbs.	213°	1665 cub. in.	40 lbs.	268°	676 cub. in.
20 lbs.	228°	1277 cub. in.	45 lbs.	276°	607 cub. in.
25 lbs.	241°	1040 cub. in.	50 lbs.	282°	551 cub. in.
30 lbs.	251°	880 cub. in.	55 lbs.	288°	505 cub. in.
35 lbs.	260°	764 cub. in.	60 lbs.	294°	466 cub. in.

With these data it is easy to estimate the gross amount of power produced by a given consumption of coals in a given engine; and knowing by experiment the nett of duty performed, we ascertain the loss of power by waste of heat, friction resistances, &c.

If we take the case of a 70-in. engine, with 10 ft. stroke in the cylinder, and suppose the steam to be admitted at 45 lbs. to the square inch during 1-6th of the stroke; what duty ought it to perform? The area of cylinder being 3848 in., and initial pressure 45 lbs.; we have a total pressure per square inch of 173,160 lbs. This moved through 1·66 ft. (space during which steam is admitted) gives the quantity of work = 173,160 × 1·66 = 288,600 lbs. raised 1 ft. high before the steam is cut off.

We next have to find the quantity of work done by the expansive steam. As I stated in my last article, the pressure of this steam decreased, by "Mariotte's law," in proportion to the increased space it occupied; and upon this principle, having the ratio between the space open to the initial pressure and the space in which the expansion takes place, which is the "index of expansion" (in this case 6), we find the entire pressure exercised during the expansion by multiplying the work done by the unexpanded steam by the hyperbolical logarithm of this index of expansion. In the present instance, hyp. log. 6 = 1·79176; and 288,600 × 1·79176 = 517,100 lbs. raised 1 ft. high by the expansive power of the steam. Altogether, we have the work done throughout the whole stroke thus—

By the initial steam	3848 × 45 × 1·66	= 288,600 lbs. raised 1 ft. high.
By the expansive steam	288,600 × 1·79176 (hyp. log. 6)	= 517,100 lbs. raised 1 ft. high.
Total		805,700 lbs. raised 1 ft. high.

Now, the cylinder being 3848 sq. in. area, and the steam being admitted during 20 in. of the stroke, the quantity of steam consumed to do the above work will be 76,960 cub. in.; and since the relative densities of steam and water (specific volume of the steam) at 45 lbs. pressure is 607, this volume of steam will contain 76,960 ÷ 607 = 126 cub. in., or 4·55 lbs. of water.

Then, on the supposition that 1 lb. of coals will evaporate 9·5 lbs. of water, 0·479 lbs. of coals will be required to evaporate the 4·55 lbs. of water required for this stroke, the gross power of which was 805,700 lbs. raised 1 ft. high. At this rate 112 lbs. of coals would raise 188,000,000 lbs. 1 ft. high. By calculating the weight of water in the pumps, and ascertaining the number of strokes, and the quantity of coal consumed during a certain time, we can find how much work any engine has performed, calculated in pounds lifted 1 ft. high for each cwt. of coals consumed. This is called in Cornwall the "duty" of an engine. In the case we have taken of a 70-in. engine, it is possible that the effective duty might be found to be 90,000,000 lbs. raised 1 ft. high, which would show that more than half the whole gross power of the steam is consumed in loss by radiation, imperfect condensation, friction, and pitwork resistances.

There are several other important points connected with the Cornish engine, which I cannot refer to here; but one or two I will just mention. In practice, it is invariably found that the pressure in the cylinder is less than that in the boiler. This is attributed to various causes, and is probably due to a combination of many; the principal one probably is the manner in which the steam is admitted, which is, as it were, by intermittent puffs, between which the temperature and pressure of the steam is constantly increasing; and, the steam space being small, this pressure naturally decreases rapidly on the connection being opened with the cylinder. Indeed, this small steam space is the weak point of the Cornish arrangement, the proportion between it and the volume of the full length of the stroke open to the steam never being very great, sometimes not more than six to one. In such a case, 1-6th of all the steam accumulated since the last stroke being suddenly taken away, we might naturally expect a momentary decrease of pressure; this difference of pressure is of course a los Every effort is made to decrease it, by giving a large area to the valve and steam-pipes, for which the Cornish engine is very peculiar. The area of the steam-pipe varies from 1-40th to 1-60th of that of the cylinder, but should never exceed the former.

Other sources of loss are the "priming" of the boiler; and the cooling of the expanding steam probably always carries off more or less vesicular water—according to De Pambour 5 per cent.,—and with the small steam space of the Cornish boiler it is probably more than in ordinary cases. The cooling of the expanding steam is also inevitable. Now, it has always been a doctrine, laid down by all engineers, that in the Cornish engine these difficulties were to a great degree met by the adoption of a steam-case, or jacket. It has been stated over and over again that the economy of this jacket has been found by repeated trials to be at least 10 per cent.; and a celebrated French mining engineer, M. Combes, states that in one trial he made with a double-acting engine working highly expansively (the steam being only admitted 1-10th of the stroke) the increased economy from this source amounted to between 30 and 40 per cent. The reasons given for this economy are that the high temperature of the case evaporates the vesicular water, and thus utilises it, besides preventing a decrease of temperature in the expanding steam, and thus preventing condensation by keeping it saturated with heat. These are not theoretical reasons, but, on the contrary, suggestions to account for an alleged observed practical fact; for theoretically, it must be admitted, there would be no gain by the use of the jacket,—it is entirely a question of fact.

With all the alleged benefits arising from the use of the jacket, which are stated by the highest authorities to have been ascertained by accurate experiments, and particularly all the Cornish engineers, I certainly was not a little surprised to see it so utterly condemned by Mr. James Sims, in the recent numbers of the Journal. Of course, Mr. Sims may be right, and the supposed benefit arising from its use may be all a delusion; but certainly, if it is so, it is a very remarkable instance of how people can deceive themselves. As I said before, the question is not one of theory but of experiment; and by careful experiment the matter should be decided.

SALES OF LEAD ORES.

SOLD DURING THE QUARTER ENDING SEPTEMBER, 1859.

Mines.	Tons.	Amount.
Minera	1050	£15,061 6 6
Wheal Mary Ann	350	6,342 9 6
Lisburne	420	6,264 0 0
Wheal Trelawny	284	6,052 2 0
Maesyssrn	320	4,508 10 0
Wheal Exmouth	340	4,461 5 0
Laxey	200	3,800 0 0
East Darren	220	3,714 18 6
Tamar	180	3,697 18 5
Rhosesmore	245	3,576 5 0
Cwmystwith	230	3,421 5 0
Herodsfoot	140	3,298 2 6
Foxdale	200	3,135 0 0
Wheal Ludcott	150	2,696 15 0
Dylife	175	2,568 6 6
Wheal Wrey Consols	144	2,439 14 0
Vale of Towy	176	2,424 9 6
Maesyrerwddu	157	2,296 1 3
Westminster	150	2,092 10 0
Cargoll	115	2,031 18 3
Cwm Erin	102	1,738 6 0
Holywell Level	95	1,477 12 6
Goginan	82	1,469 18 0
Deep Level	105	1,455 0 0
Round Hill	90	1,299 16 5
Orsedd	70	1,073 15 0
East Wheal Falmouth	40	1,016 8 0
Keswick	74	1,014 17 0
Newtownards	70	1,001 0 0
Wheal Frank Mills	100	980 0 0
Llanerchyr Aur	65	926 12 6
Nanteos and Penrhiw	74	909 12 9
South Garras	44	898 14 0
Mount Pleasant	58	819 10 6
Bryntail	60	792 15 0
Dyfngwm	54	774 16 6
Central Minera	55	748 17 6
Brynford Hall	48	717 9 0
Coetia Llys	46	688 15 9
Caldbeck	73	674 0 6
Rhoswydol	45	642 18 0
Bronfloyd	40	597 10 0
Herward United	45	592 10 0
Gellirhciron	40	541 0 0
Cwm Brwyno	36	535 10 0
East Tamar	40	490 0 0
Cwm Sebon	20	411 4 3
North Wheal Trelawny	18	381 14 0
Plas Newydd	25	380 12 6
South Betsy	22	336 1 0
Abbey Consols	25	321 17 0
Nant-y-Car	24	320 8 0
Pool Park	22	316 5 0
Catherine and Jane	22	305 16 0
Cae-conroy	18	256 8 0
Ballyvirgin	22	224 10 6
Talacre	15	223 7 6
Redmoor	16	223 4 0
Speedwell	16	212 7 6
Treweatha	11½	183 8 0
Merllyn	13	180 10 0
Aberdovey	13	180 7 6
Carmarthen United	12	164 2 0
Snowbrook	10	160 0 0
Pennant	10	143 15 0
Bog	10⅛	136 14 10
Tees Side	10	136 5 0
Harwood	10	135 10 0
Alt-y-Crib	8	111 0 0
Nether Hearth	7	95 8 9
Great Wheal Alfred	6½	87 10 10
Cardigan Consols	6	84 15 0
Garreg	3	44 2 0
Total	7250	£113,037 6 0

BLENDE.

Minera	260	£ 1,110 10 6

SALES OF BLACK TIN.

SOLD DURING THE QUARTER ENDING SEPTEMBER, 1859.

Mines.	Tons.	Amount.
Dolcoath	207	£16,322 8 2
Carn Brea	116	8,648 0 0
Great Wheal Vor	78	6,252 7 0
Pedn-an-drea	58½	4,869 10 10
Drake Walls	58	4,713 14 0
Tincroft	63	4,440 15 0
Cook's Kitchen	60	3,974 5 9
Par Consols	46¼	3,525 0 0
St. Day United	47½	3,447 12 9
Wheal Kitty (St. Agnes)	43¾	3,360 15 5
Wendron Consols	37¾	3,228 5 2
Boscean	43	3,132 3 2
Great Wheal Busy	43¾	3,083 9 6
Great Wheal Fortune	32	2,593 15 9
Bescundle	32¼	2,491 10 6
Great Hewas United	32	2,411 13 2
Carnyorth	27¼	2,013 11 6
Trelyon Consols	26⅛	1,801 14 3
Wheal Butler	24	1,748 6 9
St. Austell Consols	22½	1,726 10 9
West Fowey Consols	18¼	1,485 3 0
East Lovel	16¾	1,446 2 0
North Wheal Busy	20	1,221 4 5
North Crofty	15	1,136 6 4
West Providence	16	1,113 9 9
Boscaswell	16	1,092 12 0
Kitty and Mary United	15	1,021 11 0
Carn Galver	11¼	998 4 0
New Wheal Vor	11	933 8 6
North Levant	12	844 5 11
Wheal Kitty (Lelant)	11	765 17 6
Ashburton United	9¼	709 6 5
Bosorne and Bollowall	10	685 5 8
North Basset	—	672 2 0
Rosewall Hill	7¾	611 12 6
North Roskear	9	545 8 2
Wheal Basset	8	542 10 0
Penhalls	6½	534 7 9
Wheal Enys'	7	519 6 6
Wheal Union	—	455 0 9
Spearne Consols	5½	376 8 11
Prideaux Wood	4⅛	338 3 8
West Basset	—	328 16 4
East Basset	5	318 10 6
Camborne Vean	5	301 7 0
Trevenen and Tremenheere	3¼	274 16 3
Great Treveddoe	4¼	257 18 7
Great Wheal Alfred	—	250 1 10
West Par	3	232 14 11
South Carn Brea	—	233 12 4
South Frances	3	195 12 10
Carvath United	2¾	191 3 8
St. Dennis Consols	2½	175 9 2
United Mines (Gwennap)	1¾	141 3 0
Wheal Union	2	135 12 0
Wheal Agar	1	50 18 10
Trevoole	¾	38 5 10
Wheal Charlotte	¾	45 2 10
Grambler and St. Aubyn	¼	11 12 0
Total	1369¼	£105,835 6 10

Rolling Wheel Tyres.—Mr. Nathan Washburn, Massachusetts, has patented an invention which consists in the combination of a set of reducing rollers, a series of adjustible carrying rollers, or their equivalents, and a frame or holder thereof, supported so as to be capable of rising upward within the wheel tyre in proportion as the diameter of the inner periphery may increase during the process of rolling, the said carrying rollers being arranged and made adjustable with respect to their holder and the reducing rollers. He makes a pair of reducing rollers mounted respectively on two shafts arranged within a suitable frame. The boxes of the superior shaft may be applied to the frame, so as to be capable of being elevated or depressed therein by means of screws or other suitable equivalents, so as to enable the distance between the peripheries of the two reducing rollers to be changed as circumstances may require.

An Eccentric Inventor.—The Vicomte Marie de Botherel, who died the other day in very straightened circumstances at Dinan, formerly possessed a large fortune, but got rid of it all through his unquenchable love for commercial speculations. His chief folly was the building of an immense establishment, including 15 kitchens, and starting omnibus restaurants; 12 of these vehicles carried hot viands, and 12 cold, all over the city; while 24 more supplied all Paris—or would have done so—with wine and liqueurs. He lost all his fortune by this freak except 260,000 fr., and this he got rid of in a very short time as a wine merchant on a gigantic scale. He has left behind him a work, in 4 vols., on *Human Infirmities*.

GEOLOGICAL NOTES ON SOME MINERAL DISTRICTS OF SPAIN.

HUELVA DISTRICT.—*(Continued).*

On examination, it will be found that all the large bunches, or "masas,' of sulphur ore which are met with in different parts of that east and west strip of country bear a strong resemblance to one another in their geological position and nature. Like the smaller deposits, they are, in their length, parallel to the grain of the surrounding country rock, their walls, in going down, exhibiting frequently gentle bends and undulations, but dipping in the main likewise parallel to the foliation and longitudinal cleavages of the enclosing laminated and massive rock. The plane of junction between the deposit and the country rock is mostly marked by a lining of soft argillaceous substance, frequently (for example, at the Rio Tinto and Tharsis Mines, &c.), conspicuous on account of its whitish colour, which lining, more especially where several inches in thickness, shows traces of a lamination that is parallel to its plane; and embedded in its substance we notice now and then specks of pyrites, of apparently more modern growth. The enclosing walls are frequently noticed to bend inwards (towards one another) near the points of contact with the upper oxidised part or back of the deposit—a circumstance which may be owing to the very gradual shrinking (on account of loss of sulphur, &c.) of the latter during the process of decomposition, and the consequent diminution of pressure against the walls on either side. That appearance has given rise to the supposition of the respective deposit increasing in width downwards.

The mineral of which the bulk of such bunches consists distinctly exhibits a crystalline cleavage structure, which on comparison would seem to be similar to that of the surrounding rock. That cleavage structure is less perceptible in zones which are filled with very coarse-grained mineral, but becomes more distinct in proportion as we approach to zones of finer grained mineral; and where the latter is very dense and very fine grained, we notice it to exhibit quite distinct, smooth, half open, longitudinal cleavages, enclosing occasionally thin laminæ of slate, and the planes being in all cases covered with a film of oxidation.

As regards the percentage in copper of such bulky masses of mineral, it has been observed that within the general bulk there occur channels, or zones, in which the mineral is of a higher percentage than in other parts; and it would hence appear advisable to watch carefully the mode of occurrence of such richer zones, for by thus being able to ascertain and define their position and bearings, we might plan the operations of extraction in such a manner as to extract all the mineral from such richer zones, leaving standing in the shape of supports only the poorer mineral. Independent of zones, it has been found, at Rio Tinto, that the fine sand-like portion of the mineral which accumulates on the floors of the working (being now and then removed) is richer in copper on an average than larger pieces, which is ascribed to the circumstance that copper pyrites easier crumbles to pieces than iron pyrites.

Sometimes (for example, at Rio Tinto) the deposit contains more or less thick veins of a whitish argillaceous substance, which veins run mostly parallel to the direction in length of the deposit; judging from their composition, traceable structure, and position, such veins would appear to be the remnants of bands of rock enclosed within the deposit, and the principle of their occurrence would hence appear the same with that of the thin laminæ mentioned above, and, to some extent, with that of "horses," or isolated roundish or tapering masses of rock, which likewise are met with in some deposits—as, for example, a horse of laminated rock within the mine of Tharsis, of granular rock at El Castillo, &c. Where the enclosed mass of rock is laminated, then its laminæ are in all the instances observed parallel to the lamination or main cleavage of the surrounding mineral and its country rock. Those who, in trying to decipher geological facts, prefer the somewhat more tedious, slow, but sure way of a practical investigation that does not despise even the most minute and apparently insignificant details, to the habit of accounting for the existence of the whole by hypothetical dogmas that, by pretending to know already the real causes of all, render detail investigation unnecessary, will find a comparative examination of all the parts of such deposits highly interesting and useful for their guidance in the planning of any works, in forming estimates of probable continuation in depth, &c. Certain indications seem to lead to the conclusion that the extent in depth of those "masas" would not be in proportion to their superficial extent. On another occasion I shall treat more fully on this subject.

The water met with in those deposits is generally highly impregnated with copper, in one part of the Rio Tinto Mine so much so, that the copper precipitated from it on iron amounts to a considerable quantity. The water which, permeating from the surface through, or slowly passing in any other way near, to the oxidised back of the deposit, would most probably take up a portion of the sulphates that had been formed, and are forming, there in the course of the decomposition of the sulphur ores, and would re-deposit such sulphates in any cavities to which air has access; hence those numerous stalactites and incrustations of sulphates on the roofs and walls of ancient workings, which, on being removed, are again being reproduced in a short time. Owing to the extraordinary bulk of those "masas," and the comparatively shallow depth at which they are met with, the quantity of mineral which they would yield would only depend upon the scale on which the respective mining operations are carried on; and it may be said that the low percentage of the mineral in copper is compensated by the facility with which it can be brought to grass. The extraction of the small percentage of copper, in the cheapest and most efficient manner, and so as to utilise at the same time the sulphur, arsenic, &c., which are contained in the mineral, is a desideratum in that district which has as yet by no means been reached.

The following may serve to give an idea of the mode of reduction which is actually practised at the present time. The ore, after being reduced to a convenient size (not too fine nor too coarse), is piled up in oblong pyramids, which rest on a substructure of firewood, by which the whole is to be ignited. Sometimes those calcination piles, or "teleros," are covered on the surface by other badly calcined mineral, called "tierras blancas," and residues from former calcinations. After ignition, the pile continues burning, the sulphur of the mineral serving as fuel, and it takes from six to eight months before the whole pile is calcined; and the process is, besides, subject to many irregularities and accidents, owing to its being done in the open air, and to various other causes. The loss of weight during calcination is estimated to amount to from 20 to 26 per cent. The ore thus roasted, and great part of whose sulphuret has now been converted into sulphates, is now exposed to the action of water in dissolving tanks ("pilones dissolvadores"), which are lined with asphalt, and in which the water is renewed about once a week, till the water that is tapped off contains no more sulphates. All the water drawn off from the above tanks is made to pass into "pilones reposadores," in which tanks it remains just long enough to allow any earthy, &c., particles which it may hold in suspension to settle down. The liquor coming from the "pilones dissolvadores" may contain from 5 to 6 per cent. of copper in solution; from the "pilones reposadores" it passes to the "pilones de cementacion," which contain piles of ingots of iron, upon which the copper is then precipitated,* the time required for precipitation being in proportion to the surface of iron that is exposed to the liquor; hence it would be better if the iron was cast in flat plates instead of ingots. During the cementation the water has to be continually kept agitated. When the water assumes an apple-green colour, and no more copper is precipitated on a piece of clean iron dipped into the liquor, then the cementation is finished. The proportion of iron consumed to copper obtained is very fluctuating, because subject to various influences; but it may be assumed to be from 2 to 3 tons of iron to 1 ton of copper. Before the precipitate or "cascara" is scraped off, from two to three charges of fresh liquor are passed through the "pilones"—the time required for each fresh precipitation to be completed varying according to the percentage of salts of iron and copper contained in the liquor, according to the quantity of iron employed, and to the temperature. More iron appears to be consumed in proportion if the liquor contains much sulphate of iron. If the liquor is not drawn off immediately after the copper has been precipitated, a precipitation of subsalts of iron takes place, and adds to the impurities of the "cascara;" the precipitation of those sub-salts, however, should take place in another repositor, the sediment formed in which is called "papucha," and contains from 8 to 10 per cent. of copper.

During the scraping off of the adhering "cascara" from the iron, carbon and minute portions of iron are separated therefrom, and likewise add to the impurity of the cascara, so that the latter contains only about 50 or 52 per cent. of copper, and often much less. After that the cascara is pressed and slightly washed, and then mixed with some "papucha," and made into balls, so as to prevent its being blown away as dust, and in order to facilitate the smelting of it; and subsequently the copper is smelted out in furnaces.

* While I was at Rio Tinto a German engineer was about trying experiments, with a view of precipitating the copper by means of *sulphuretted hydrogen*.

At Rio Tinto natural cementation is carried on by the water of the mine, which contains copper in solution, being made to run through narrow wooden channels, which are lined with asphalt, and have a fall of 1 inch in 100, and into which iron ingots, &c., are placed. The cascara obtained from this natural cementation is much purer than the other.

It will be seen that by the process of roasting in the open air nearly all the sulphur is lost, the sulphurous acid fumes poisoning the vegetation all around. Then it is certain that only a portion of the sulphur ore in the "teleros" will be changed into sulphate; while another portion will remain nearly unchanged; and a third portion, owing to too much heat, be changed into oxide—both which latter will be left undissolved in the residue; while during rainy weather a portion of the sulphates in the teleros will be carried off by the rain water; so that the whole method, as actually carried on there, would certainly appear as one of the most wasteful that could be resorted to; and there is no doubt that, if any of the mines as carried on now produce a profit, it might be doubled by the introduction of a better and more economical system and management. JULIUS.

MINING AND VENTILATION IN WESTPHALIA.

DESCENT INTO THE "ZECHE" PRASIDENT, NEAR BOCHUM.

In selecting a mine to quote as an example of the manner of working coal in Westphalia, I feel myself fortunate in having visited and examined quite carefully the Prasident, near the busy manufacturing town of Bochum, not only because it is one of the oldest, largest, and completest establishments in the country, but because of the attention I received from its skillful and polite director, Mr. Cental. This gentleman was secretary of the mining department of Hungary when Kossuth was Governor, but upon the assumption of power by Austria he, being forced to fly, became first a civil engineer and then director of this mine. It is a pleasure to hear his enthusiasm as he tells of the happy Hungarian land, which he loves and hopes soon to see free, and of his children, who speak together in Hungarian, and whom he teaches to practice the customs of their native country. With the versatility of his educated countrymen, he here enters upon the consideration of the minutiæ of a single establishment with the same assiduity with which he was used to plan and execute works on a large scale. And I found him contriving a machine for greasing wagons with as much interest and care as he had in other times opened a new mineral region in the valley of the Drave. The Prasident was one of the earliest mines sunk in the chalk formation. As I have before remarked, even in the mining schools here, before 1837 it was said that no coal was below the chalk. The boring in 1838 to 1839 showed this assumption to be false, and the shaft which was sunk in 1840 to 1841, and began to be worked in 1845, is said to have been the first out of the coal schists from which fuel was raised. At present about 75,000 tons are taken out per year, but as soon as the war cloud shall have blown over, and business resumed its usual settled condition, it is the intention of the company to put it in order to raise 1000 tons per day.

It was early morning when I arrived at the mine and began to make preparations to descend. The "obersteiger," or man who has the general superintendence of the underground works, was to be my guide, and he came provided with all necessary clothes. Unlike the miners in Belgium, the workmen here have adopted no particular uniform, but wear clothes only to be distinguished from the peasants and mechanics of the vicinity by the greater amount of grease and mud which naturally collects upon them. The officers of the mine usually wear a short black blouse, furnished with cape and ruffles, and adorned with buttons bearing the miners' emblem—the "hammer and schlagel," or crossed hammers, which form one finds everywhere here, built with black bricks in the house walls, glancing from the tile cottage roofs in all the contrast of red and brown, or surrounded by wreaths in the society rooms.

We pass through the room in which the miners leave such articles as they do not care to take into the pit—their coats, caps, trowsers, and, in many instances, their pipes and canes. The last two luxuries very few Westphalian miners will be without, and the piles of bamboos and curbed sticks which collect in one of these apartments is surprising. Wishing to see the mine from the top downwards, we descended upon the ladders, which are the usual means of passing up and down for the miners. Although there is a law forbidding descending and ascending in the cage, it is usually disobeyed by the officers. The shaft is a rectangle, 17 ft. long by 7 ft. broad on the interior, and it is divided into four parallel passages—one 6 by 7, in which two pumps work, one 4 by 7, which contains the ladders, and two 6 by 3, which are used for the cages in ascending and descending. The ladders lead from platform to platform, and are about 25 ft. long. The rungs are formed of a single piece of wood 2¼ in. high, protected on their upper side by a rectangular strip of iron which is let into the wood. On our way down we passed several workmen who, with their lamps hanging on the slimy timbers, sat repairing the pumps, and occasionally in the division at our right hand the cages loaded with coal would rush by at the rate of 12 miles per hour.

At length we arrived at the upper level, or "weather sohle," which is now only used as a means of collecting the air in the ventilation. It is 404 ft. from the surface, and 136 above the lowermost level, which lies 540 ft. below day. Here we turned off to see the ventilating power. The working shaft serves only as a downcast. The air, after circulating through the mine, is driven out through a separate ventilating shaft 400 ft. in depth and 6 ft. diameter, situated about 200 yards to the south of the ventilating shaft. Two furnaces are required to produce the necessary force. They each have a grate surface of 2 ft. 5 in. by 4 ft., and burn together 2400 lbs. of coal per day. They are placed in a large space excavated in the rock, and each consists of two parts—an under portion, like a common grate and narrow chimney, which rises at an angle of about 40 degrees for 50 feet, joins the perpendicular shaft, and a parallel canal 6 by 7, along which the air rushes and joins the draught up the shaft immediately above the aperture of the chimney. But one of these furnaces is required in winter, but now both are active, producing a draught which extinquished our lamps when we exposed them to its full force. The ashes from these furnaces are carried out in the passage and carefully left to cool, after which they are packed away in the empty rooms.

Leaving the furnaces, we passed through various passages of the mine, sometimes seated in a small car and pushed by a "putter," who walked behind, sometimes on foot along narrow passages where the water stood three inches deep on the floor, and sometimes down chimney-like holes by means of muddy ladders, where every 30 or 40 ft. was obstructed by a trap door, until at last we stood upon the lowermost "sohle" of the mine, 540 ft. from the surface. To carry the reader with me during all these windings would require more space than I am at liberty to use, but a conception of the stratification and the underground arrangements, which is the result of these explorations, can be given in a briefer form.

The coal beds upon which the shaft is sunk lie at an inclination of about 60 deg. northward; at the distance of a few hundred yards occurs an anticlinal axis or basin, which rises towards the east, so that, in fact, the shaft enters the formation on the south rim of a small basin, and the workings extend entirely around to the north or opposite side. One may start near the shaft in a gallery excavated in the coal, and follow it toward the east. The way gradually bends to the left, and the coal, which dips north at first, changes as he turns, until at length he finds himself going westward, and the same seam dipping to the south. It was with much pleasure that I explored this subterranean basin, for I found it an exact counterpart of that at the Treverton Company's works, near the Susquehanna river, in the well-ordered gangways of which I first saw the phenomena. The series of seams here consist of nearly 20, varying from 1 ft. to 98 in. in thickness; about seven of these are at present worked. These seams are divided by schists from 10 to 100 ft. in thickness, which consist of a clayey slate and sandstone, resembling the strata about Pittsburg.

All the coals are raised from the 80 lachter, or 540 ft. level, but all the mining is done above this depth, and the coals lowered by inclined planes to the undermost gangways. The mining is done by what is called the "Pheiler Bau," which is the plan generally adopted in Westphalia. The process is as follows:—

A seam of coal, say 4 ft. thick, and rising at the rate of 50 deg., is to be taken out. The first operation is to cut a "Querschlay," or gangway, through the rock at right angles to the strike, into the coal. This is generally 7 ft. broad and 7 ft. high, and it is subsequently furnished with a double track railway. Upon reaching the coal the passage, still maintaining a direction nearly level, turns into the coal, its size is reduced, and a single track road is laid down. Near the junction of the "Querschlay," with the seam a headway 7 ft. wide, and the height of the seam, is driven in the coal towards day. This is intended to act as an inclined plane.

From the side of the heading, and at right angles to it, and, therefore, parallel to the lowest passage in the seam, are driven each 27 ft. (4 lachters), other passages 7 ft. high, and in each of these a railway is also laid. Thus the entire seam is cut into pillars 27 ft. wide, and any convenient length, generally about 500 ft. The upper one of these galleries (here there were five) is connected to the ventilation shaft, and the lower with the downcast, by means of passages, along which the coal is transported. In driving the "Querschlay," when it is long, air is furnished by means of a tin face, turned by a boy, which drives a stream through wooden tubes about 8 in. square, that are laid to the furthermost end.

As the several parallel passages above mentioned are being driven through the seam, they are ventilated for the first 120 ft. by the air which passes through the plane itself. After that distance is reached the inclined plane is closed, and the air made to pass from the under to the over gallery, through passages cut in the pillars near where the men are engaged. These passages are themselves closed and new ones opened as the work proceeds. At last, when the seam is ready for stoping, or taking out the pillars, the course of air is along the lowermost level to the end of the pillars, across their ends, where the men are to work back by the uppermost level, and then off by an especial channel to the ventilating shaft.

"Apbau," or stoping, now begins. The highest pillar of the series is taken by two men, who, beginning at the end furthest from the inclined plane, proceed to take all the coal away, except a section on the top 3 ft. thick, which forms the floors of the highest gallery, and which is left, in all instances, to protect the workmen from falling objects. The coal, which is mined by the men standing on platforms one above another against the face of the coal, which is precipitated into the passage below, and thence transported in wagons to the inclined plane, to be lowered to the level of the bottom of the shaft. When the first pillar is forward some 25 feet another set of workmen attack the second pillar, working it in the same way. When this has proceeded 25 ft. the third pillar is commenced, and so on. When the roof is not bad, but one prop to 6 ft. square is required, the workmen always keeps four rows of these behind him, and as a new row is added, and the furthest one drawn out by chopping the stone away at the foot and dragging them out with a long pole. Thus all the coal is taken out except the 3-ft. at the top of each pillar, and all the wood is saved.

The method of getting the coal to the shaft is now to be mentioned. Loaded into the wagons by the "putters," it is pushed along the several galleries to their mouths at the inclined plane. Of these planes there are six in the mine, the longest of which has a length of 390 ft. The object is the same as that described in the Belgium mines—to lower the full and bring back the empty cars. But the plan adopted is quite different. There a loaded car is made directly to draw up an empty one—here a separate "cage is used, and a counterweight. The plane is 7 ft. wide, and has two sets of rails, one 5 ft. wide, for the cage, the other 2 ft., upon which the counterweight runs. This weighs 2000 lbs., and is a flat slab of cast-iron which moves under the cage. The two are joined together by a one-inch wire rope, which runs at the head of the plane twice round a cylinder 4 ft. in diameter, upon the end of which is a break-wheel, so arranged that the whole apparatus is readily controlled by one man. The cage is made to stop before any gallery at will. A wagon of coal is pushed on, and it descends to the bottom, at the same time drawing up the weight, an empty wagon is now pushed into the place of the full one, and the weight being allowed to descend draws it to whichever level it is needed. The full wagons are then pushed to the bottom of the shaft and drawn to surface.—*United States Railroad and Mining Register.* R. H. L.

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The Nangiles setts are situate in the parish of Kea, in the county of Cornwall, and are held severally, under leases of 21 years, from the Right Hon. Viscount Falmouth and Messrs. Graham and Hill, at 1-18th dues; and adjoin the Great Gwennap Consols and Wheal Clifford on the west, and are not equalled by any other ground in the country. The western portion thereof was producing, upwards of 40 years ago, from 500 to 600 tons of ore per month; but the works were discontinued on account of some misunderstanding with the then landed proprietors and their tenants, which has now been satisfactorily adjusted. The north part thereof is in virgin ground, and is traversed throughout by the Gwennap Consols lodes, which have been proved in this ground to be very rich. The Wheal Clifford and the United Mines adjoining are still very profitable, and producing large quantities of ore; most of the lodes of these mines also run through the setts of this company. In Wheal Clifford most important discoveries have lately been made, and the shares of which have risen in value within a very short period nearly £100 per share. A reference to the *Mining Journal*, and Mr. J. H. Murchison's valuable work upon *British Mining*, will assist in forming a correct judgment as to the value of the property.

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EXTRACTS OF REPORTS.

Wheal Uny, Aug. 4, 1859.—It is a fact well known that the Consols and United have been the most productive mines in the country. Wheal Clifford is at present a rich mine, and paying good dividends. The situation of Nangiles is unexceptional. The extent of the sett is 550 fms. on the length of the lodes, and 700 fathoms in width. The mine is traversed by two elvan-course, one of which is the same that runs through the Consolidated Mines, and in connection with the same lodes made rich courses of ore. The old workings are confined to some four or five lodes in the middle of the sett. The engine-shaft is sunk 86 fms. below the adit; here large quantities of copper ore, tin, iron pyrites, and blende have been raised. About 60 fms. south of the engine-shaft another shaft is sunk, with the intention of laying open Wheal Clifford lode; this is so much work done towards an important object. To the north of Nangiles shaft there is a large piece of unexplored mining ground of great importance: some of the Consols and St. Day United lodes must run through this piece of ground. There are now about 20 tributers at work in Nangiles above the 46 fm. level: they are breaking from 100*l.* to 150*l.* worth of copper, tin, and blende per month. If a shaft or two were put up in proper order below the 45 fm. level several other pitches might doubtless be worked. I have carefully examined the mine both at surface and underground, and believe it to be a first-rate speculation. JAMES ROWE.

Treruffe, near Redruth, Aug. 4, 1859.—Nangiles has proved very productive of the ores of copper and tin, with endless quantities of iron pyrites and blende, which latter minerals have hitherto been of secondary importance to the miner here, and, therefore, neglected, but there is now a daily increased demand for these ores in the manufacturing world—so much so, that there is every probability of raising at once sufficient sulphurous minerals to meet all the current expenses of the concern. There are few such speculations to be entered on in this district, and I confidently believe that success may be ensured by a judicious management of the mining operations. JOHN GARRY.

West Wheal Damsel, Dec. 7, 1856.—From the 40 fm. level and upwards the lodes are such as are seldom seen in old mines, and will warrant being developed to a much deeper level. I understand there is nothing done under the 80, where the lode in the western end is large, and letting down a great quantity of water, which proves it to be of an open character, a most desirable indication in this locality, and from its relative position to the best dividend-paying mines in the country, there can be but little doubt of its productiveness in depth. There can be but one opinion as to the lodes in the Consols being found in this sett, north of the engine-shaft. I saw a tribute pitch* at the bottom of Bread and Cheese shaft (80 fm. level), working at 5*s.* in 1*l.*; it could be worked at much less, but for the quickness of the water. I think of all the speculations in the neighbourhood Nangiles stands pre-eminent, offering to the capitalist every guarantee of success, if properly worked. JOHN MOYLE.

Nangiles Mine, Aug. 4, 1859.—Bread and Cheese shaft (which is further west on Nangiles lode) is sunk to the 80, where the lode is about 1 ft. wide, a very good lode, imbedded in a beautiful elvan. The man who last worked in bottom of this level offered to pay the cost of the mine if the adventurers would keep the engine at work, but they had previously decided on stopping, and there was no one in authority to work any longer. It is only to clear up and secure this shaft, and eight men might be employed immediately at 6*s.* 8*d.* in 1*l.* The last ore sampled from this level produced between 14 and 15 per cent. for copper. The 70, in Bread and Cheese shaft, has been productive, and if cleared would employ four men at about 10*s.* in 1*l.* Dunstan's shaft is sunk to the 50, on Deeble's lode. This lode has been productive of a great quantity of tin, and has at present a very promising appearance, and I have no doubt, when properly explored, will prove a very rich lode. I do not think it wrong to say there are full twenty lodes running more than half a mile through this sett. EDWARD DOWER.

* Now, Aug. 4, 1859, still standing.

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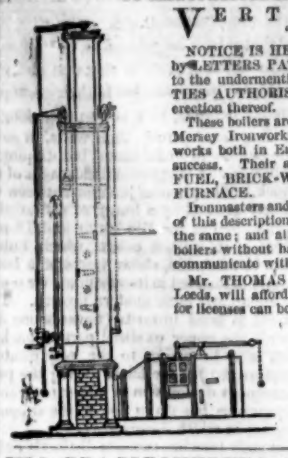

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